How does the steam turbine gland sealing system work?

This question previously had details. They are now in a comment.

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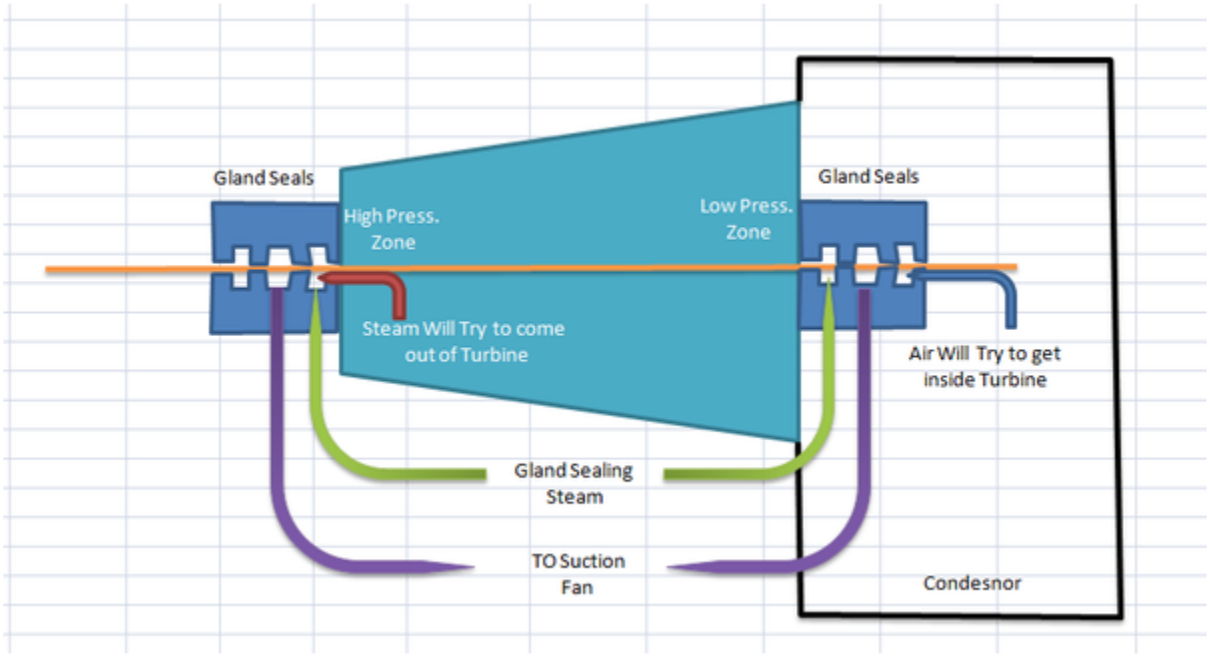
11 Answers



Bhola Shanker, Its all about Power..
Updated Sep 1

Gland Sealing System(GSS) of a steam turbine - The steam turbine inlet pressure will be in Hundreds of Bar but when the steam exit , the pressure drops to either well below atmospheric pressure (Condensing Turbine) or at relatively lower pressure (Extraction turbine).

Since the Turbine shaft has to rotate freely there has to has some gap between the shaft and the turbine casing, from where either Steam will try to escape out or Atmospheric air will try to sneak in.



As the diagram explains, During turbine start up the gland seal steam has to be given at both the ends, so that condensor will be isolated from the atmosphere and Vacuum pulling can be started.

But as the turbine started taking load , steam at inlet side will try to come outside due to difference of pressure across the gland seals at that point the gland sealing steam can be stopped to HP end

seals and self sealing will be achieved whereas at Low pressure zone the sealing steam has to be maintained always.

The middle section of the gland seals are usually (for higher rating turbine) connected to Sealing fan system(gland condenser fan), which sucks air + Steam from the gland seals, and pumped into a heat exchanger where the steam is condensed and thereafter air will be vent into the atmosphere.

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Nitesh Garg, Rotary Equipment Engineer. More then 8 years of experience
Answered Dec 29, 2015

For understanding the gland sealing system first we have to understand why it is required so there are two main reason.

1. As turbine exhaust is Connected to a condenser which is operated below atm pressure so there are chances of air ingres or vacuum brake in turbine which is eliminated by gland sealing

2. As steam entering side is having very high pressure so chances of steam leakage is there through steam glands which are reduced by gland sealing.

Now we will understand how this system works.

So there are two principles one at the time of starting the turbine and while operation of turbine.

1. During the turbine startup there is a vacuum at the exhaust side so in both end steam gland we provide an external steam through a drilled hole in steam gland which creates a barrier for air to enter in turbine. Pressure of this steam is less then 1 kgf/cm2.

2. While operation the steam supply valve which supply gland sealing is closed but the stream leaks through the front side of the turbine which is high pressure side enters in gland sealing line and goes to the exhaust end.

Both the side gland leakoff line are connected to gland condenser. And sealing steam lines are connected to a flush chamber through a pressure control valve.

Thanks

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Akshay Singh Tomar, Engineer, Singer, Funlover
Answered Feb 18, 2016

The two functions of the turbine glands and seals are:1

1. To prevent or reduce steam leakage between the rotating and stationary components of the turbines if the steam pressure is higher than atmospheric.
2. To prevent or reduce air ingress between the rotating and stationary components of the turbines if the steam pressure is less than atmospheric. The last few stages in the low-pressure (LP) turbines are normally under vacuum.

The leakage of steam or air could occur where the shaft is extended through the turbine endwalls to atmosphere. A power loss is associated with steam leakage or air ingress. Thus, the design of glands and seals is optimized to reduce any leakage.
Modern steam turbines use labyrinth glands to restrict steam and air leakage. However, the carbon ring gland is still used on some older turbines.

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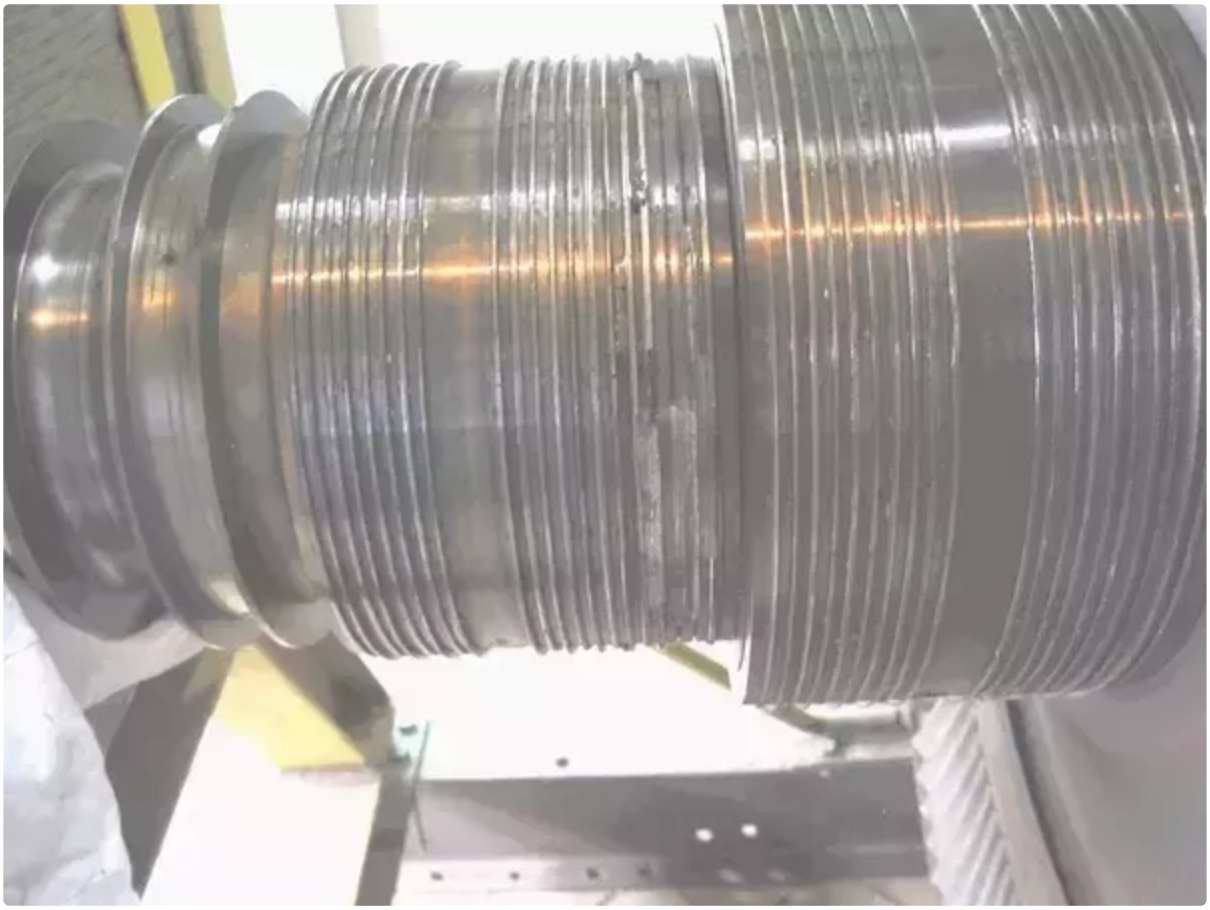


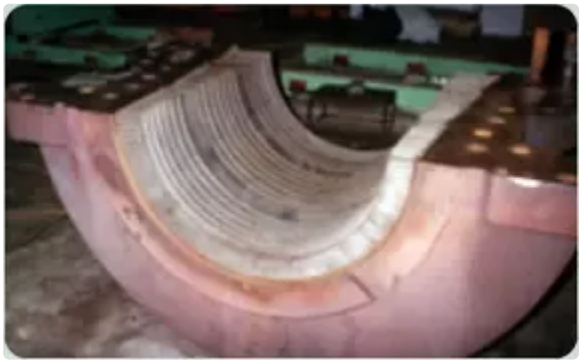
Vicky R, B.E Mechanical Engineering, Srinivasan Engineering College, Perambalur
Answered Oct 2, 2016

Actually, Gland Sealing means it used to protect from leakage of steam between the rotor and the Casing.

This is the area where is gland seal is present.

Gland Seal: It is an assembly which is used to prevent the leakage of steam, fluid or water between Sliding or turning part of the machine elements.





In simple words i can explain you that during the starting of the turbine the pressure used to rise inside the turbine while the outside remains as a atmospheric temperature. so due to temperature difference the steam used to leak out. to prevent this leakage we are using gland sealing system.

in which low pressure steam is used to sent in the gland sealing from outside so that the steam from inside won't come outside.

so that it also helps in increasing the condenser vacuum and avoiding the leakage of steam. this is the basic concept behind it.

Let we See it deeply,

But, nowadays due to the improvement which have made everywhere Gland sealing system comprises of two sections. first section supplies steam to HP/IP turbine gland and the second section supplies steam to LP turbine gland. During startup & shutdown and low load conditions, auxiliary steam is used. During running Condition, leakage steam from HP/IP turbine gland is used to seal the glands of LP Turbine. Low Temperature steam is used at LP gland. so, LP desuperheater is used to control the temperature of this steam.

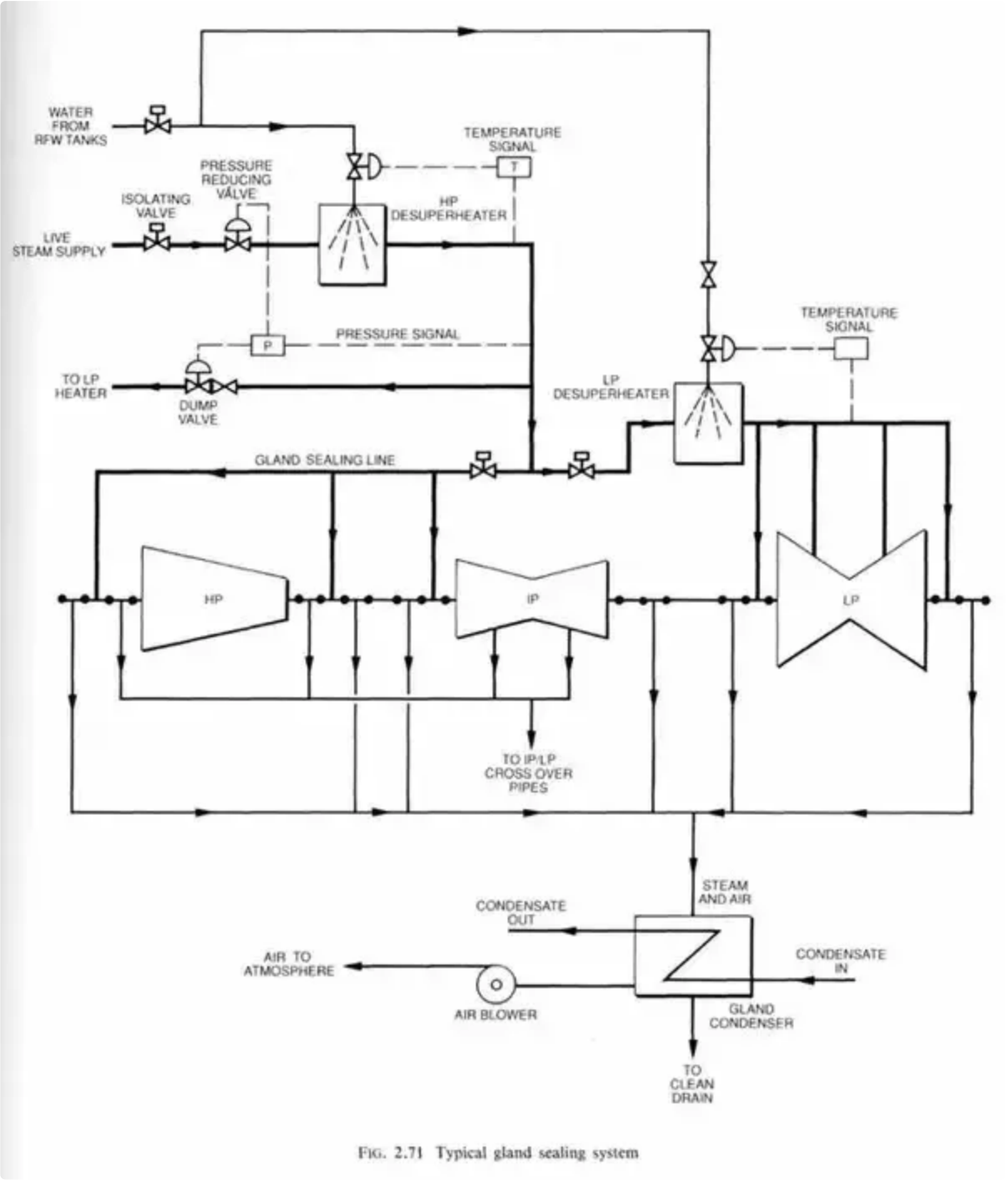


FIG. 2.71 Typical gland sealing system

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Sidhartha Bajpai, Professor in marketing at Visiting Professor (2016-present)
Answered Aug 22, 2016

This video explains is well . No words will be required.

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Rahul Patwa, works at Students
Answered Apr 18, 2015

I am a power engineer and the following answer is based on my experience.

The HP and IP turbines are installed with lybnaith seals which are nothing but the grooves, on passage through the grooves the steam will lose it's pressure. Till the plant is operating below 40% load some steam will leakoff and is disposed in to gland seal cooler. One should note down that the steam is provided by APRDS.

The LP turbine is sealed by leakoff steam of IP n HP turbine. LP turbine is connected to condenser itself so the leak off steam of lp turbine is disposed into condenser. The turbine will be self sealed after 40% plant load.

Hope it will help you

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S.K. Mani, B.E. Mechanical Engineering, PSG College of Technology, Tamil Nadu, India (1964)
Answered Jan 17

- The gland is a system finely machined grooves in the shaft and housing. The system cf contols the steam leakage by precisely defined and machined groves thar th leakage path between the stator is designe as a throttle groove where the sream progressively loses its energy and leakage is reduced to a trickle and the condensed water is collected, polished and used again as feed water.
- Longer the leakage path and smaller the gap of the mating grooves the lower will be the leak.
- As there is al ways a differential expansion and precise mounting and care full calculations of other influences such a the deflection and swelling of rotor and reduction of the gap should be calculated and at no point the grooves on the stator and rotor rub each other.

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Ibrahim Osama Ibrahim, Teaching Assistant (2017-present)
Answered Mar 8, 2016

if you have two different pressures across a flow channel (pipe or duct)

then the flow will take place from the higher stagnation pressure to the lower one, and if you are asked to reduce the flow through this channel, what will you do ?

sure, you will build up obstacles in the fluid way between the two different pressures such as a valve.

the same idea is used in the gland sealing you have two different pressures and you build up obstacles in the flow path to reduce the flow rate.

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Douglas Ray Roper, BSME Mechanical Engineering, University of Maryland, College Park

(1980)
Answered May 4, 2016

Because of the temperature, and pressure, a simple seal, like used on the crankshaft of on internal combustion engine will not work.

At the inlet to the turbine, the steam is superheated and at high pressure. I believe the seal is created through a series of overlapping glands with minimal clearance between them. The series of glands creates head loss. With sufficient head loss, the flowrate can approach zero.

At the outlet to the turbine, the pressure has typically been reduced to below atmospheric. it is accomplished thru a series of glands which overlap. Minimal clearance between the glands creates head loss. With sufficient haed loss the flow rate approaches zero. Of course there will be some blowby, primarily in the form of liquid water.

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Shane Tennent, INTP-A
Answered Mar 24, 2015

Steam turbine gland sealing system

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Ashish Devganiya, studied at Gujrat Technological University
Answered Feb 26, 2016

The turbine gland sealing system supplies steam to the shaft glands of the main propulsion and generator turbines, to prevent the leakage of air past these glands with the attendant loss of condenser vacuum. The system also recovers excess sealing steam when the turbines are operating as high loads and are self sealing.

When starting up at low speeds and when going astern, sealing steam for the main propulsion turbines is supplied from the 150 psig auxiliary steam system. A gland seal regulator automatically regulates the pressure in the steam header, maintaining 1-1/2 to 3 psig by admitting steam from the auxiliary steam system. As the load increases, internal pressure at the H.P. end of the turbines increases and the regulator closes in on the steam supply. At higher loads, excess steam is unloaded by the gland seal regulator to the L.P. turbine fifth stage or to the main condenser. The hydraulically operated sealing and unloading valves are actuated by oil from the ship's L.O. system steam leak-off steam from the maneuvering valve is led to the gland sealing circuit.

Gland sealing steam make-up lines from the 150 psi steam system as well as the low point in gland seal lines are drained to fresh water drain collecting systems via thermostatic traps. The line for excess unloaded by the gland seal regulator is drained by a 1/2 inch drain line fitted with an orifice to the main condenser hotwell.

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